Concentrating Solar/Gas Hybrids
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Randy Gee

Duke Solar Energy

Raleigh, NC

Who are We ?

Duke Solar Energy LLC is a joint venture between:

Duke Engineering and Services (DE&S), **one of the country's leading engineering services firms, and**

Solar Roof International (SRI), **a unique owner management team experienced in the fields of building construction and design, energy efficiency, solar energy and related technologies.**

Duke Solar's Primary Markets

- Small and Large-Scale Electricity Production
- Double-Effect Solar Air Conditioning
- Building Integrated Solar Thermal

Solar Thermal ….. with Natural Gas, Wind, PV, Biomass, Microturbines

Solar Thermal Hybrid: Central Power Plant

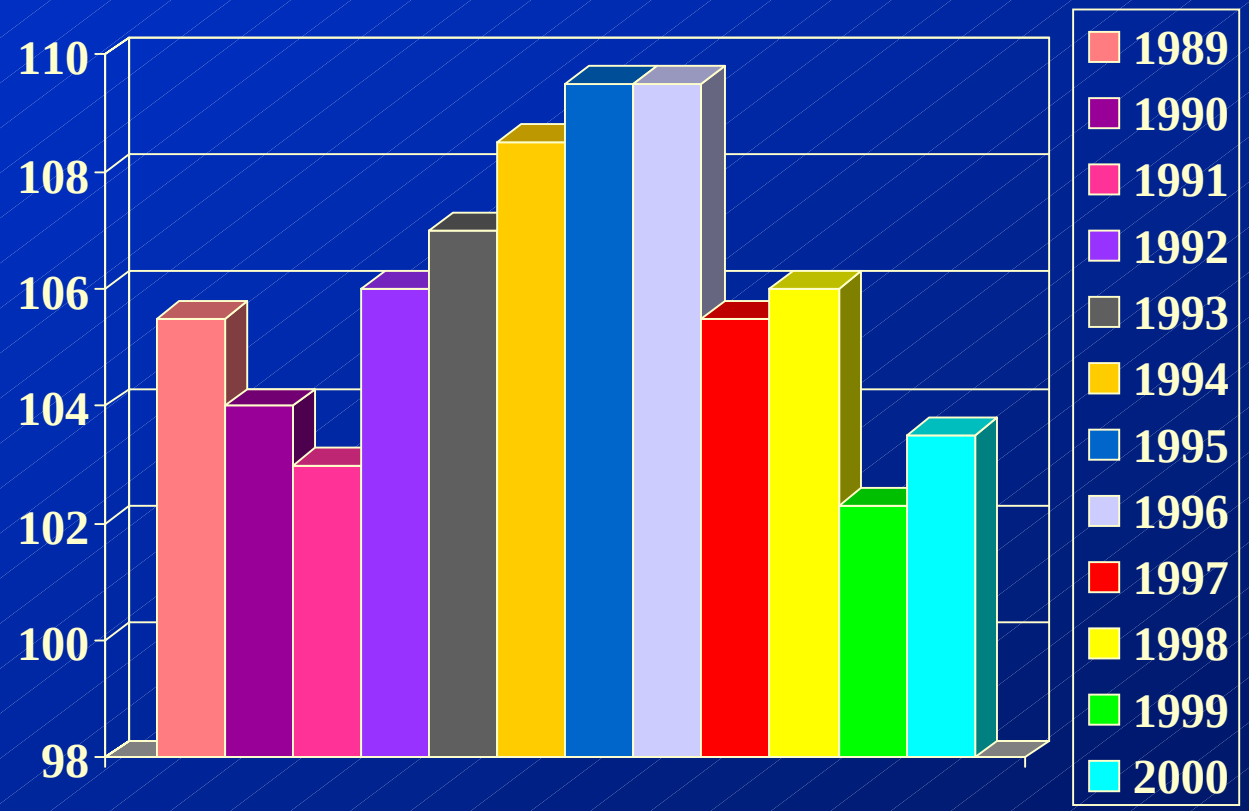
Parabolic Trough Power Generation Systems

354 MWe in Operation Over 10 Years

75% Solar and 25% Natural Gas

Solar Thermal / Natural Gas Hybrid Reliable and Dispatchable

Kramer Junction SEGS On-Peak Capacity, %



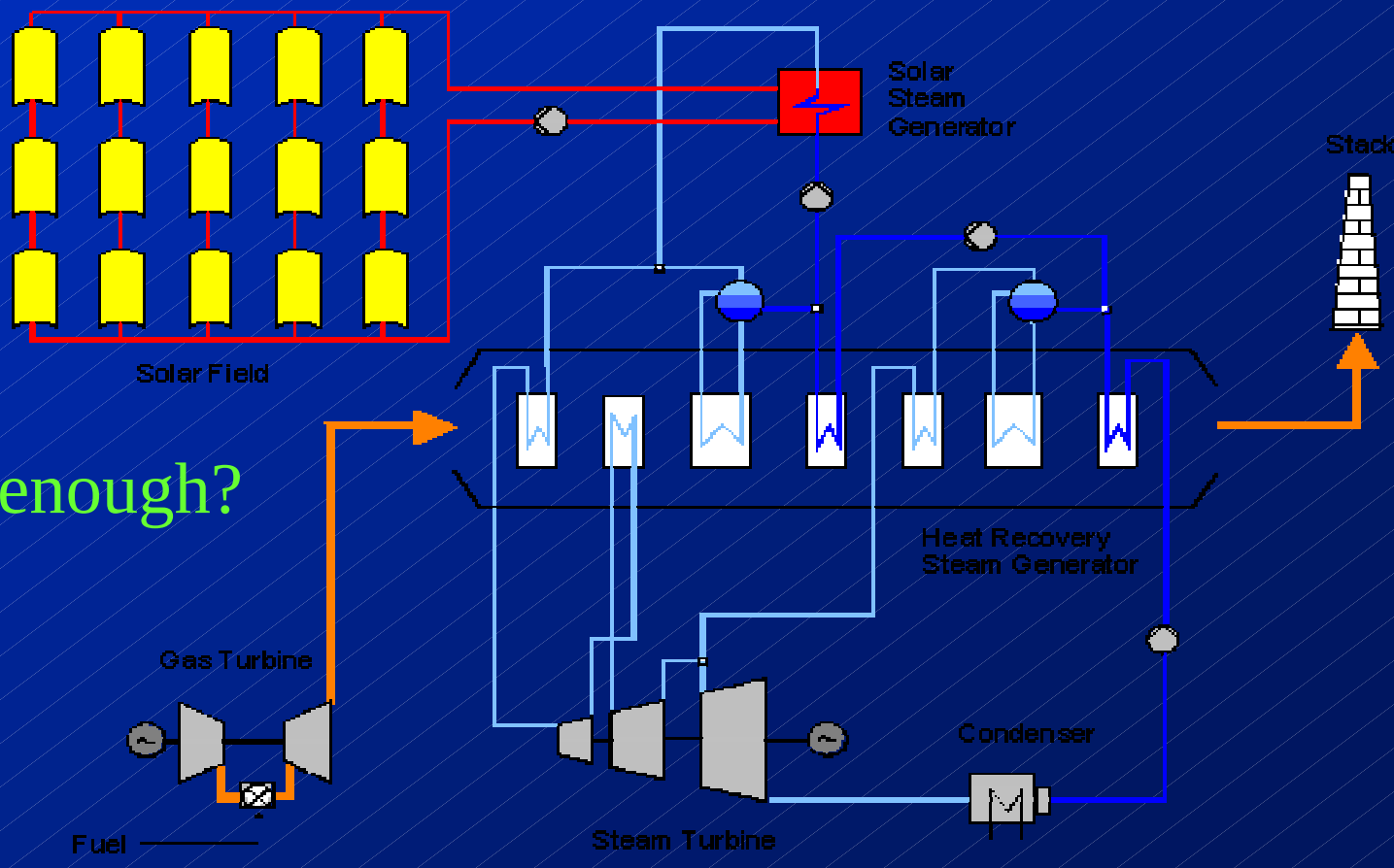
Courtesy of KJCOC

The ISCCS Solar Thermal Hybrid Concept

Gas/Solar Hybrid (30 MW Solar & 140 MW Gas Turbine)

Advantages: Efficiency, Incremental Costs, Startup

Several Plants Planned: Mexico, Egypt, India, and others



Issue: Green enough?

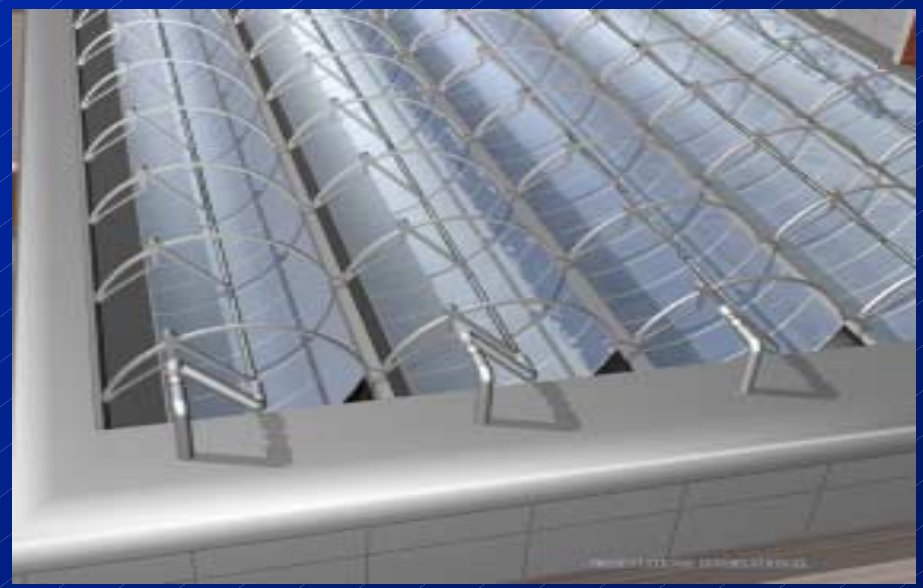
Solar Thermal Hybrid: Building Integration

Various Technology Solutions

Generate Electricity, Displace Electricity

Solar / Gas Fractions Vary with Application & Location

Fixed Array



Tracking Power Roof

20-ton 2E Chiller, Sacramento CA

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Advanced Absorption Chillers: Cornerstone of Solar Thermal for Buildings

- 2E Chiller COP = 1.2
  - Big Increase in Efficiency (COP of 1E is 0.7)
  - Major Cost Reduction of Solar Cooling
- Dual-Fired Chiller (OSU and Duke Solar)
  - Full Hybridization with Natural Gas
  - First Unit is 50-ton Capacity
- Thinking Ahead: 3E as Solar/Gas Hybrid?

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Building-Integrated Tracking Power Roof ™

High-concentration collector also serves as roofing skin. Provides daylight, heating, space cooling, and electricity.

The Parker-Lincoln Building

Under Construction in Raleigh, North Carolina

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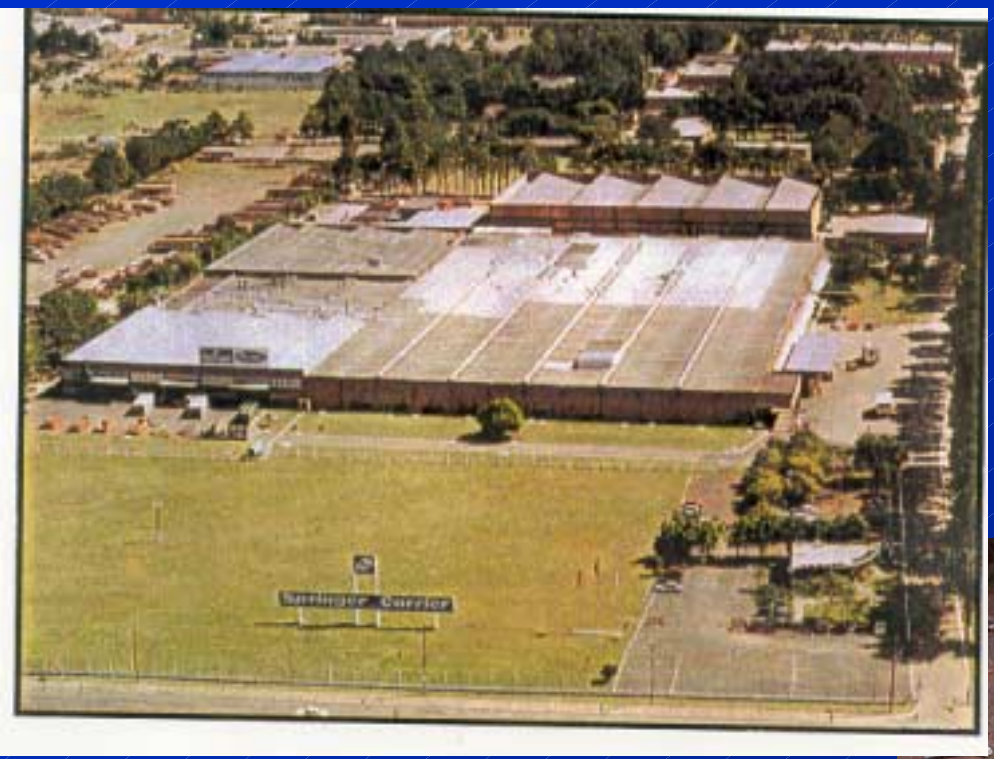
Building Integrated Fixed-Array Power Roof

New 34,000 ft2 Office Building in Charleston, SC

- Ph. 1a: Daylighting (complete)
- Ph. 1b: Solar 12 kWe, space heating & hot water
- Ph.2: Solar Cooling

VAC2005 Nonimaging Collector

Another Fixed Array Power Roof



Before

Springer – Carrier Factory

- **Ph. 1: Daylighting**
- **Ph. 2: 700 tons Cooling Plus 200 kWe**
- **Ph. 3: 1.5 MWe**

After

Solar Thermal Hybrids

- Flexible (power, heating, cooling, DHW)
- Dispatchable & Reliable
- Peak Power (Maximum Value)
- Assured Demand Reduction
- Lower First Cost
- Energy Cost Stability

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